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PRECOOLING GRAPES IN TUNNEL COOLERS

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Precooling Grapes in Tunnel Coolers

The removal of heat from packed fruit is a slow process even under the best of temperatures and air velocities owing to the tightness of the package. Fruit and vegetable containers have not been designed for fast cooling. Provision for air movement through the package to facilitate cooling has been given secondary consideration. With the usual method of precooling packed fruit, that of circulating cold air in a refrigerator car after it has been loaded, the time required for a thorough job has been increased with the advent of the crosswise load. About 14 to 18 hours are needed to cool a carload of grapes from 80° F. to temperatures of 40 to 45°, a drop of 35 to 40 degrees (U.S.D.A. Technical Bulletin 899). This amount of cooling usually necessitates holding the car over a day at the packing house. This is objected to by many shippers especially when the market is declining. Precooling in rooms prior to loading is being used but holding over night is still required to reach desirable temperatures of 40 to 45°F.

The only sizable opening for cold air to enter a lug of grapes is the space between the lid and the sides. This is usually about 2 inches wide at top of the bulge but it is partially closed by a cardboard collar. The most obvious thing to do to improve cooling is to remove the lid and expose the fruit to the air. If cooling were fast enough, grapes might be precooled in the unlidded lugs while being conveyed from the packer to the lidding machine. After some preliminary trials that were encouraging, a model tunnel cooler was built in which grapes were cooled in an hour1/. Air was directed at the face of the lug at a velocity of 600 feet per minute. Fruit and air temperatures during the test are shown in figure 1. These studies were made in 1938. The first tunnel cooler for grapes to the best of our knowledge was built in 1947. It was designed to cool 1,000 lugs of grapes in one hour from initial temperatures of 80 to 85° to final averages of 40 to 45° F. A diagramatic drawing of the tunnel, figure 2, indicates the method of cooling the fruit. The tunnel is long enough (approximately 200 feet) to hold 1,000 lugs. Fans blow air from the bunker downward at the grapes as they move through the tunnel. Air blast temperatures of 25° to 30° are maintained by ammonia coils in the bunkers. During the hour's cooling the fruit in the top of the lug is cooled to a temperature only a degree or two above the temperature of the air blast whereas that in the bottom of the lug may be 40° to 50° when it leaves the tunnel. When loaded immediately into a pre-iced car the temperature of the grapes equalizes to 45° or less within a few hours.

The refrigeration required for doing this much cooling in an hour would be prohibitive unless there were some other use for the compressors after the precooling season. In this installation they are used for cooling storage rooms and the precooling tunnel becomes a bunker for cooling air which is circulated to the rooms. Cooling 1,000 lugs of grapes 40 degrees F. by using ice for refrigeration has required about 12,000 pounds by actual test. This would mean 6 tons of refrigeration per hour, or the output of a 144 ton compressor for the cooling accomplished in the tunnel. Compressors totaling about 175 tons have been installed in the above plant and they have been adequate with some capacity to spare.

1/ Acknowledgment is made to H. T. Cory, Baker Ice Machine Company, for providing the tunnel and valuable assistance in conducting these tests.

Early in 1948 a second cooling tunnel was built for grapes. In this case there is no need for storage since the crop is all harvested for the early market. Ice was used instead of mechanical refrigeration. A diagramatic drawing of the tunnel is shown in figure 3. Grapes were conveyed through it at 4 levels, with lugs placed crosswise, 3 rows wide. The tunnel was approximately 80 feet long and held 700 lugs which were cooled in a minimum of 2 hours. The ice bunker was 2 1/2 feet wide, 6 feet deep and extended the length of the tunnel. It held 33,000 pounds of ice. Ten 20 inch propeller type fans were installed 8 feet apart in the bunker wall. They had a combined capacity of about 60,000 c.f.m. The air blast from the fans encompassed the top 2 layers of lugs and the bottom two layers were cooled by the air as it returned to the bunker. A baffle was placed between the second and third layers to divide the airstream into discharge and return and prevent the air by-passing the fruit.

Two tests were made in July when maximum outside temperatures were 108° and 112° F. respectively. Desirable air temperatures of 29 to 34° were maintained by re-icing the bunkers every 4 hours and using 500 to 1,000 pounds of salt at each re-icing. This amount was equivalent to 1.5 to 3 percent of bunker capacity. Ice meltage during the warmest day amounted to 45,000 pounds when 2,600 lugs were cooled. The lidding room at the far end of the tunnel and the loading corridor were also supplied with cool air from the bunkers thus adding to the ice needed for cooling. The run-off from the bunkers was checked from time to time and it was equivalent to 60 to 70 pounds of ice per minute, or 3,600 to 4,200 pounds per hour.

The grapes were cooled 20 to 30 degrees F. in the tunnel and another 5 to 10 degrees after they were loaded in the car. Car fans were operated in pre-iced cars during loading and also after loading until about 10:00 P.M. when the cars were released for shipment. The fruit averaged 55° or less when it was shipped which was about 10 degrees warmer than desired, but was still a fairly safe temperature. Faster cooling could be obtained in the tunnel if air were directed at the face of each lug.

If it were feasible to cool grapes before they are packed the job could be done much quicker than in an unlidded lug. Individual grapes are relatively small and if they could be reached by cold air, they would cool quickly. Some tests were made with Thompson Seedless grapes, using thermocouples to measure the temperature of individual berries in the top, middle and bottom of bunches as they were cooled (Fig. 4). When air was blown across the bunches as they rested on a flat, solid surface comparable to a belt conveyer, the grapes showed a drop of 35 degrees from 82° to 47° F. in 20 minutes with air at 40° F. When air direction was changed to a downward blast at the grapes, cooling was accelerated and 5 minutes of cooling time was saved. Fastest cooling was obtained by directing air downward at grapes resting on 1/2 incl mesh wire screen when a lowering of approximately 40 degrees was obtained in 11 minutes. Air velocity during these tests ranged from 500 to 1,000 feet per minute.

The main reason for precooling grapes quickly is to keep them from losing moisture and from developing decay. Other fruits that soften and become overripe in transit, such as pears, apples, peaches, and plums, would show additional benefits from quick cooling by checking the ripening process.

A carload of grapes, stacked in a precooling room or refrigerator car, requires 14 to 18 hours for precooling. When cold air is blown downward at grapes in unlidded lugs the job can be done in an hour or two. When individual bunches were exposed experimentally to cold air of high velocity, adequate cooling was accomplished in 15 minutes.

FIG. 1 COOLING RATES OF GRAPES IN UNLIDDED LUG

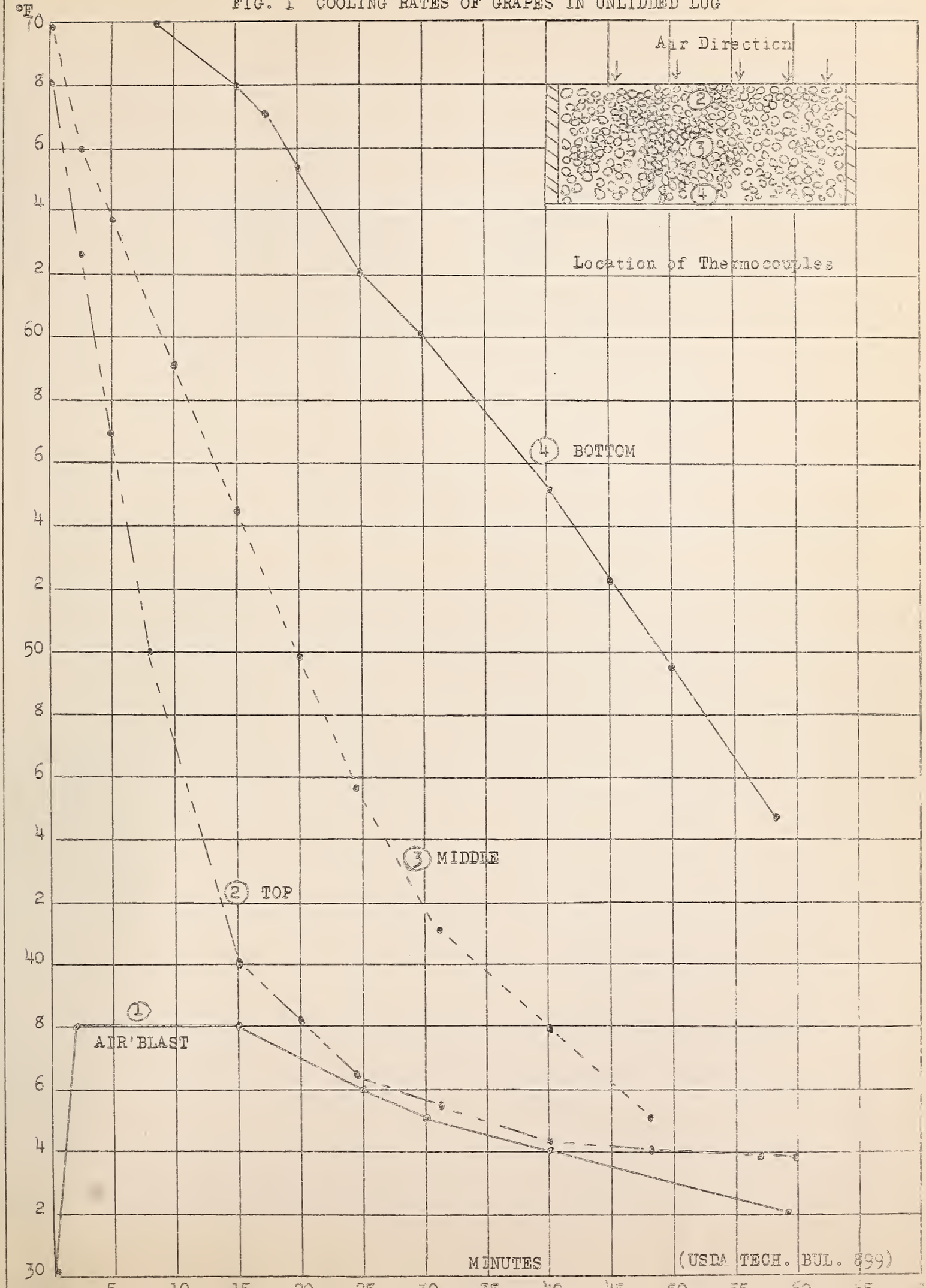


FIG. 2 TUNNEL COOLER FOR GRAPES

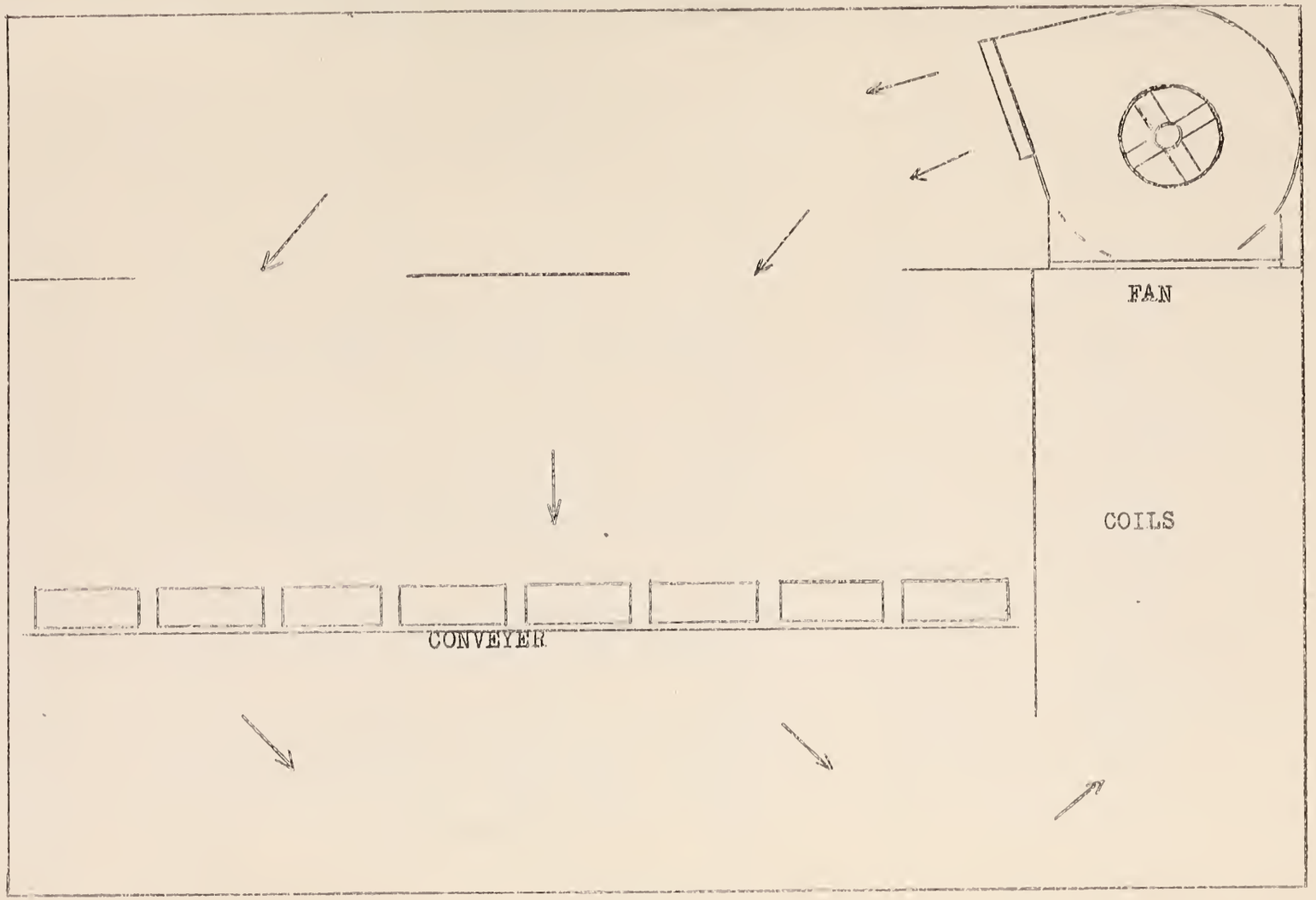
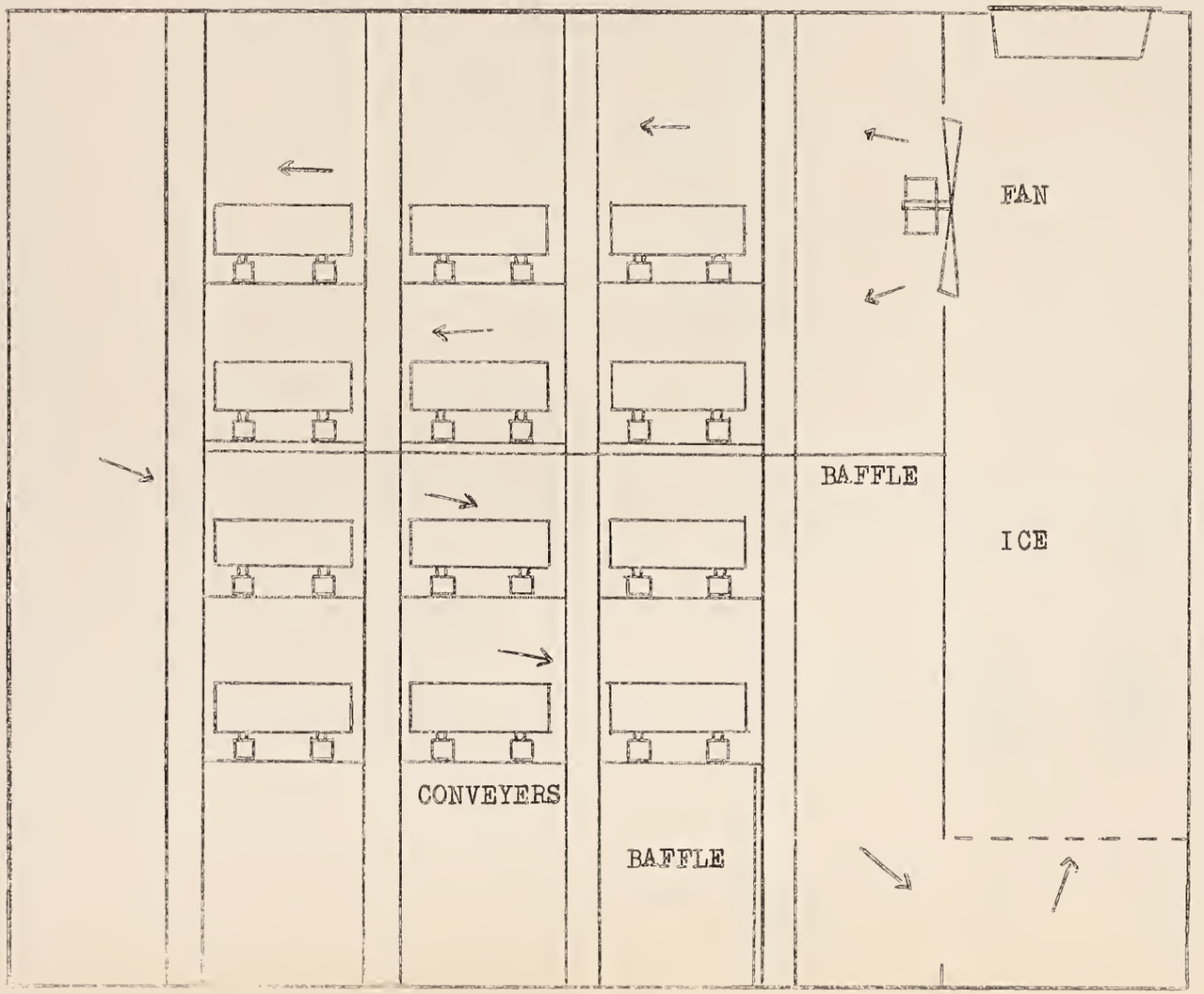
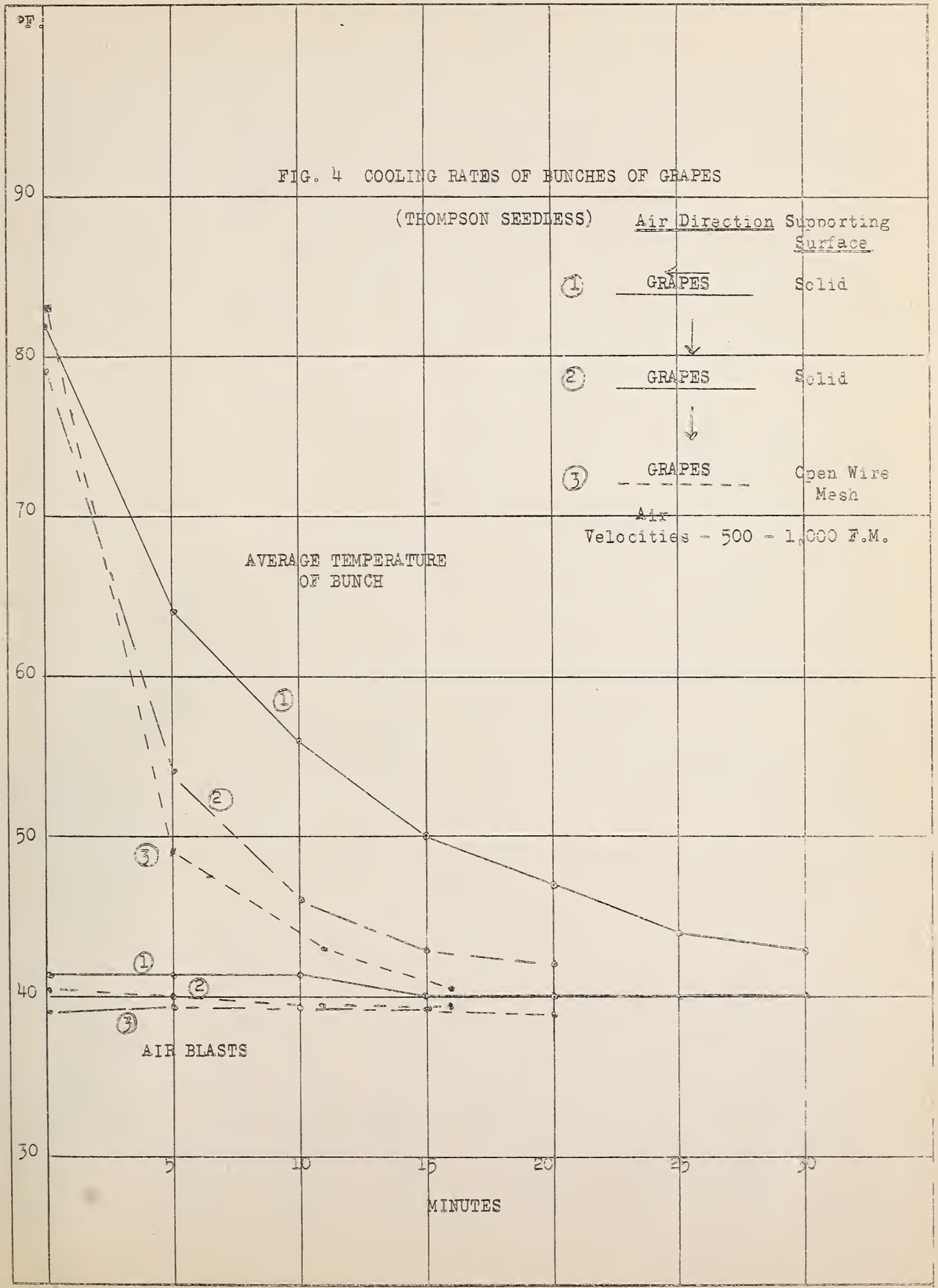


FIG. 3 COOLING TUNNEL FOR GRAPES




°F.
90
80
70
60
50
40
30
FIG. 4 COOLING RATES OF BUNCHES OF GRAPES
(THOMPSON SEEDLESS)
Air Direction
Supporting Surface
① GRAPES Solid
② GRAPES Solid
③ GRAPES Open Wire Mesh
Air Velocities - 500 - 1,000 F.M.
AVERAGE TEMPERATURE OF BUNCH
AIR BLASTS
5
10
15
20
25
30
MINUTES